#5 763

TR 88
35

Versar INC.

REVIEW OF ENVIRONMENTAL DATA RELEVANT TO BRESCO FACILITY OPERATIONS AND DEVELOPMENT OF RECOMMENDATIONS FOR 1989 BRESCO NPDES PERMIT

Prepared by

A.F. Holland
A.T. Shaughnessy
L.C. Wendling

Versar, Inc.
ESM Operations
9200 Rumsey Road
Columbia, MD 21045-1934

Prepared for

Department of Natural Resources
Power Plant and
Environmental Review Division
Tawes State Office Building
Annapolis, MD 210401

December 1988

FOREWORD

This technical memorandum, "Review of Environmental Data Relevant to BRESCO Facility Operations and Development of Recommendations for 1989 BRESCO NPDES Permit" was prepared by Versar, Inc., ESM Operations, at the request of Mr. James M. Teitt of the Power Plant and Environmental Review Division, Maryland Department of Natural Resources. The work was completed under Tasks BH-1 and BH-2 of PPRP Contract PR86-043-01(89).

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

I. INTRODUCTION

The Baltimore Refuse Energy Systems Company (BRESCO) owns and operates a refuse-fueled steam electric generating facility in southwest Baltimore. The facility is located on the shores of the Middle Branch of the Patapsco River near where Gwynns Falls enters Baltimore Harbor (Fig. I-1).

The BRESCO facility was initially issued an operating permit allowing the intake and discharge of cooling water from the Middle Branch in early 1984 [National Pollution Discharge Elimination System (NPDES) Permit No. 83-DP-2119; Appendix A]. This permit expires on 2 January 1989, and in summer/fall 1988, the owner/operator requested that the Maryland Department of the Environment (MDE) initiate actions required to reissue their NPDES permit. MDE requested that the Power Plant and Environmental Review Division (PPER), Department of Natural Resources (MDNR) review the available enviromental data related to facility operations and make recommendations for alternate effluent limitations and other conditions that should be included when the BRESCO NPDES permit was reissued. The purpose of this memorandum is to assist PPER with this task by:

- Reviewing the findings of studies which were the basis for the 1984 BRESCO NPDES permit and determining if they were completed in an adequate manner and if their conclusions are supported by the available data

- Reviewing the available data for the BRESCO facility to determine if plant design and operating conditions changed during the term of the last permit

- Determining if facility operations were in compliance with evaluation criteria in Maryland thermal regulations

- Determining whether existing intake and discharge structures are the best available technology (BAT) for reducing entrainment and impingement impacts.

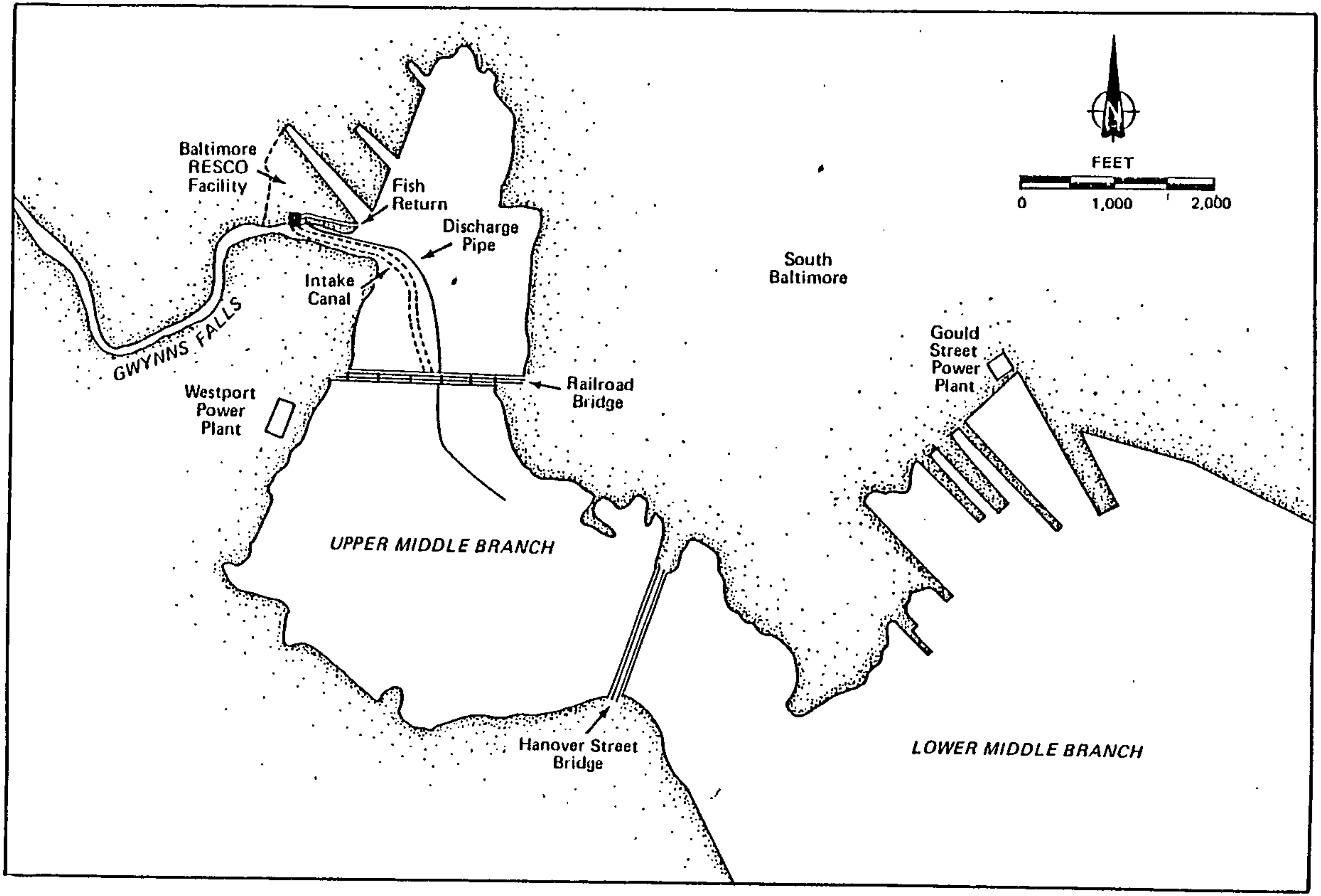

Figure I-1. Map of Middle Branch showing location of BRESCO facility (from EA 1987)

II. BACKGROUND INFORMATION

The magnitude of impacts from once-through cooling systems on aquatic biota is influenced by:

- Facility engineering design and operating practices (e.g., the location, design, construction, and capacity of intake structures)
- The magnitude of temperature increase across condensers (ΔT)
- The amount of cooling water use relative to the size of the receiving water body
- The amount of "new" water available to dilute plant effluents
- The level of power generation
- The duration of exposure to thermal discharges
- The kinds, life stages, and abundances of aquatic biota in the receiving water body.

The objective of this section is to provide background information on the modes of cooling system-biota interactions, plant characteristics, and site characteristics that will assist in understanding the information presented later.

A. MODES OF COOLING SYSTEM-BIOTA INTERACTIONS

Figure II-1 is a schematic representation of cooling water flow through the BRESCO facility showing cooling system-biota interactions. These interactions fall into three categories: 1) impingement, 2) entrainment, and 3) discharge effects.

Impingement

Impingement consists of trapping large organisms on barriers (e.g., trash racks and intake screens) that are used to keep condenser tubes free of blockage (Clark and Brownwell 1973). Impingement often causes immediate mortality by abrasion or by restricting movement of water across gills (U.S. Environmental Pro'ection Agency 1977a; 1977b). Latent mortality may also

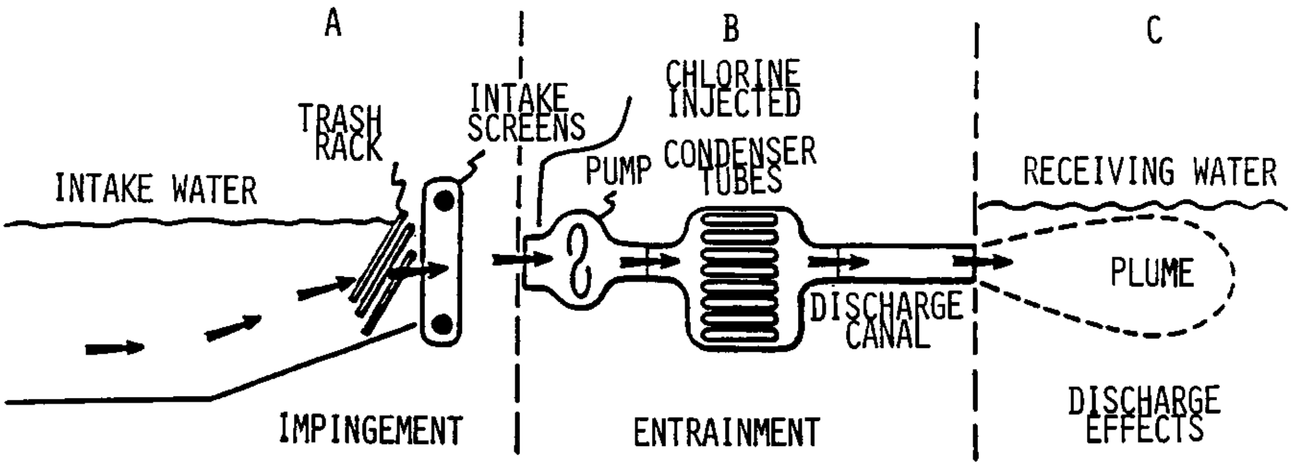

Figure II-1. Path of water flow through a facility using once-through cooling and locations of cooling system-organism interactions.

A. Organisms, mainly fish and crabs, too large to pass through the 9.5 mm intake screens or 7.6 cm wide trash racks may become trapped on them (i.e., are impinged) or in the intake region. Intake screens are periodically rotated to wash off impinged organisms and return them to receiving water.

B. Organisms small enough to pass through intake screens are drawn through the cooling system (i.e., are entrained). Entrained organisms experience a sudden temperature rise of from 10-11°C, shear and pressure forces, and many contact internal structures. Entrained organisms are also exposed to lethal levels of chlorine and its residuals during time periods when chlorine is applied.

C. Organisms surviving entrainment and impingement as well as organisms in receiving waters may be exposed to elevated temperatures and potentially stressful chemical substances in the discharge plume. Currents associated with the discharge plume may cause habitat modifications through bottom scouring and changes in circulation patterns.

occur because organisms, physically damaged during the impingement process, are more susceptible to disease and may be less able to compete when returned to receiving waters. The methods used to remove impinged organisms from intake screens and return them to receiving waters generally determine the magnitude of impingement mortality (American Society of Civil Engineers 1982). Impingement is of major concern when mortalities to juveniles of commercially or recreationally important species are large relative to the stock size of these biota in receiving waters (Hanson et al. 1977; Barnthouse et al. 1979; Barnthouse and Van Winkle 1981).

Entrainment

Entrainment is the transport of biota through the cooling water system. Because entrained biota must pass through intake screens, they are generally small. Entrained biota may experience mortality from abrasion, rapid velocity changes, shearing flows, rapid temperature increases, and exposure to toxic chemicals used to prevent biofouling (Hanson et al. 1977). Entrainment is of major concern when intake structures are located in or near spawning and nursery areas of recreationally or commercially important species and large numbers of early developmental stages are entrained (U.S. Environmental Protection Agency 1977a, 1977b). Entrainment of a large proportion of each year's spawn has the potential to adversely impact regional stocks (Boreman et al. 1978; Polgar et al. 1981).

Discharge Effects

Discharge water from electric generating stations with once-through cooling systems is generally released at above ambient temperatures and may include residues of toxic materials, such as copper corroded from condenser tubes or chlorine injected to reduce biofouling on internal plant structures. Biological effects from exposure to thermal effluents depend upon the magnitude of the temperature increase compared with ambient water temperature and the duration of exposure (Barnett and Hardy 1984). Thermal mortality is of major concern when discharge temperature exceeds 35°C (95°F). Cold shock mortality is of concern when biota attracted to thermal effluents during the winter are suddenly exposed to cold temperatures following plant shutdowns (Hanson et al. 1977; Barnett and Hardy 1984). Chlorine is toxic to most estuarine biota in the ppb to ppm range and its use is of concern when chlorine concentrations in plant effluents are greater than 0.2 ppm (Maryland Department of Natural Resources 1984). Chlorine toxicity is generally greatest at high temperatures (Capuzzo 1979). Sublethal discharge effects generally include alteration to physiological processes (e.g., growth, reproduction), movement of resident biota away from the discharge region, blockage of migration pathways, and increases in abundance of nuisance organisms (e.g., fish parasites or undesirable biota) within the thermally impacted area (Coutant 1977; Coutant and Talmadge 1977; Holland and Hiegel 1981). Sublethal discharge effects are of major concern when the productivity or basic nature of the receiving water body is adversely affected.

B. PLANT CHARACTERISTICS

Plant characteristics play a major role in the degree to which cooling system-biota interactions affect receiving waters. The major characteristics of the BRESCO facility relevant to assessing its impact on receiving waters are summarized below. Detailed discussions of plant characteristics are provided in Ecological Analysts, Inc. (1983); Rust International Corporation (1983), and EA Engineering, Science, and Technology, Inc. (1987).

BRESCO is a refuse-fueled steam electric unit with a generating capacity of about 70 MWe. Cooling water from the tidally influenced Gwynn Falls (annual average freshwater inflow of 68 m^3/min) and the Middle Branch of the Baltimore Harbor (Fig. I-1) is withdrawn by two vertical turbine pumps (total intake pumping capacity of 158 m^3/min). The temperature increase across condensers is approximately 10-11°C. Intake structures are protected by trash racks (7.6-cm spaced bars) and three 9.5-mm wire mesh vertical traveling screens (2.4 m wide) with Ristroph buckets. Impinged organisms are washed into a sluiceway and returned to the adjacent receiving waters. Cooling water is discharged into the Middle Branch, approximately 3 m below the surface via a 1.5-m diameter pipe with 14 terminal diffuser ports that is designed to rapidly dissipate thermal discharges. To our knowledge, facility design and operating characteristics have not changed since the original NPDES permit was issued in January 1984.

C. ENVIRONMENTAL CHARACTERISTICS OF RECEIVING WATERS

The physical, chemical, and biological characteristics of the water body adjacent to an electric generating facility generally play a major role in determining the nature and magnitude of plant impacts. Human uses of the receiving water body also determine the consequences of plant impacts. The environmental characteristics of receiving waters in the vicinity of the BRESCO facility that are relevant to renewing its NPDES permit are outlined below. Detailed descriptions of the environmental characteristics of the Middle Branch are provided in University of Maryland (1975), Ecological Analysts, Inc. (1983), and Kazyak et al. (1988).

Industrial development of the shores of the Patapsco River and the urbanization of the Gwynns Falls watershed have resulted in relatively degraded water and sediment quality in the vicinity of the BRESCO facility (University of Maryland 1975; Ecological Analysts, Inc. 1983). As a result of the poor water and sediment quality, aquatic habitats in the vicinity of the BRESCO facility are of relatively poor quality,and the area has been classified as Class I waters. The designated uses of these waters are water contact recreation; growth and propagation of fish, other aquatic life, and wildlife; and water supply. The abundance of many fish species are markedly reduced in the area compared to similar unpolluted habitats or other less polluted regions of Baltimore Harbor (Ecological Analysts, Inc. 1983). In addition, the incidence of fish disease is higher in the Baltimore Harbor region than it is in more pristine waters (Wiley 1975).

Recent data indicates the environmental quality of Baltimore Harbor may be improving (Holland et al. 1988; Kazyak et al. 1988; J. Veil, personal communication). The factor apparently contributing most to the improving environmental conditions in Baltimore Harbor is the large decline in point source contaminant loadings from major industrial discharges which has occurred since 1975 (J. Veil, personal communication). Although contaminant loadings to Baltimore Harbor have declined, conventional pollutant loadings (e.g., nitrogen and phosphorus) remain unacceptably high, and summer dissolved oxygen concentrations for the Baltimore Harbor region have not improved substantially since the early 1970s (Holland et al. 1988). Summer bottom dissolved oxygen concentrations in the vicinity of intakes are currently less than 2 ppm and almost always less than 5 ppm (EA Engineering, Science, and Technology, Inc. 1987).

III. MARYLAND THERMAL REGULATIONS

Operation of the BRESCO facility is regulated under the Code of Maryland Regulations (COMAR) 26.08.03.03. These regulations require that the owner/operator demonstrate that facility operations ensure the protection and propagation of balanced, indigenous populations of shellfish, fish, and other wildlife on the receiving water body in order to obtain or renew an NPDES permit, including any variance that may be required from thermal mixing zone limitations. An overview of the sequence of events required by COMAR 26.08.03.03 are presented in Fig. III-1 and are described below.

Specifically, COMAR 26.08.03.03 requires compliance with three general criteria (i.e., gates) before a discharge permit can be issued or renewed. The three gates are:

- Determination of compliance with four mixing zone specifications as a means of evaluating if water use has the potential to cause environmental harm and the conduct of biological studies to determine if non-compliance has unacceptable consequences

- Conduct of an evaluation that ensures spawning and nursery activities are protected as well as any other biological studies that may be required to determine if intake structures are the best available technology for reducing entrainment impacts

- Measurement of impingement losses and conduct of an evaluation to determine if intake structures are the best available technology for reducing impingement losses.

The best available technology for intake structures means the best technology that is commercially available at an economically practicable cost. That is, the costs of installing and operating the technology cannot be wholly disproportionate to the anticipated environmental benefits.

A. REPRESENTATIVE IMPORTANT SPECIES APPROACH

COMAR 26.08.03.03 recognizes it is not possible or cost effective to assess the effects of once-through cooling systems on all of the species inhabiting aquatic habitats. These regulations therefore provide for the evaluation of impacts on those biota which, because of their abundance, distribution,

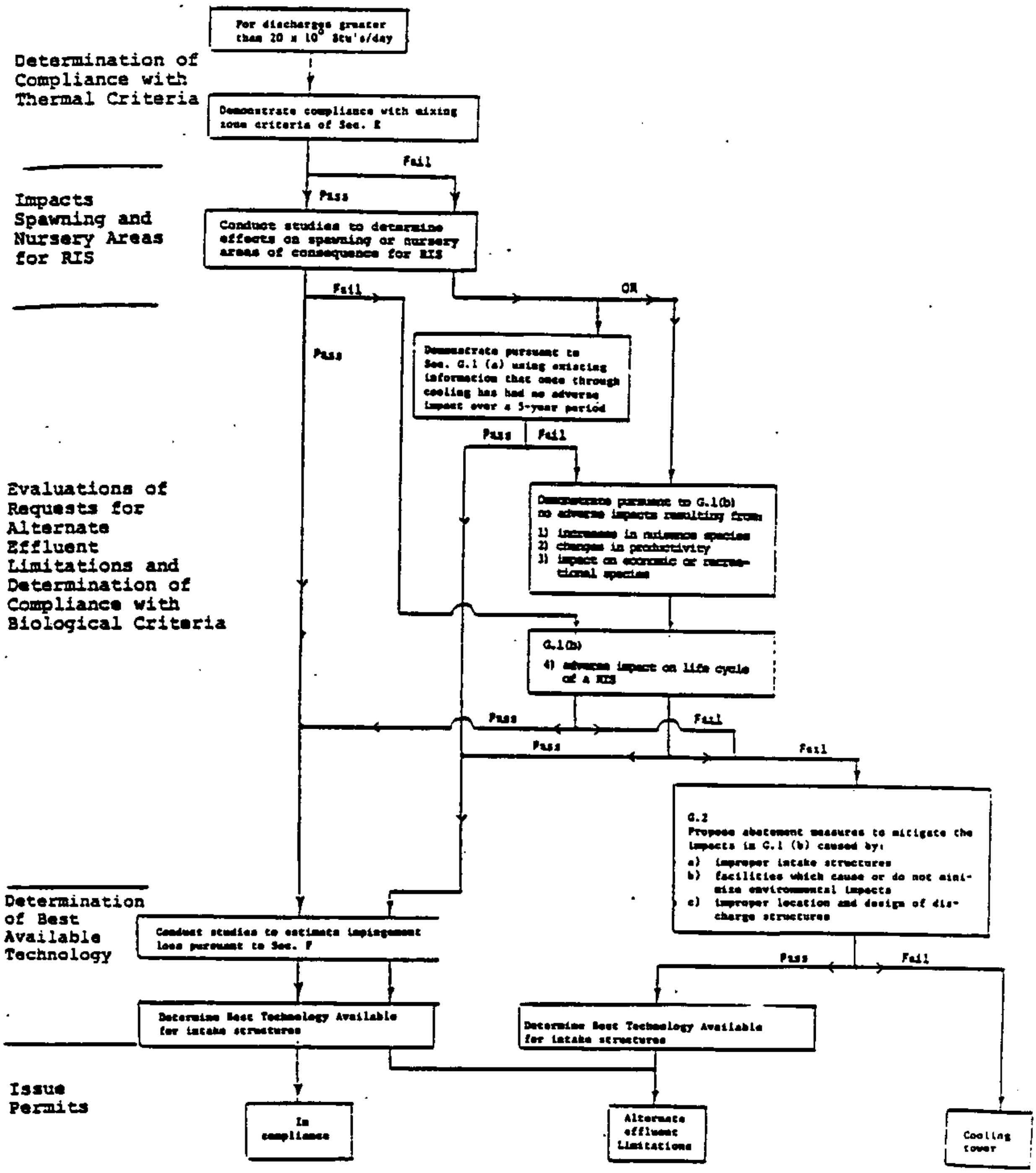

Figure III-1. Schematic diagram outlining demonstration compliance procedure described in the Code of Maryland Regulations 26.08.03.03.

ecological roles (e.g., food web linkage), or economic importance (e.g., commercially exploited species), are essential to or representative of the maintenance of balanced indigenous populations of shellfish, fish, and wildlife in receiving waters. Because most representative important species (RIS) are near the top of estuarine food webs or are key links in food webs, changes in their abundance or distribution are considered to be sensitive indicators and integrators of the degree and magnitude of system-wide impacts.

B. MIXING ZONE CRITERIA (GATE 1)

The first gate in COMAR 26.08.03.03 is determination of compliance with four mixing-zone specifications. These are:

- The discharge flow may not exceed 20% of the annual average net flow past the point of discharge which is available for dilution

- The 24-hour average of the maximum radial dimension, measured from the point of discharge to the boundary of the full-power 2°C-above-ambient isotherm (measured during the critical periods), may not exceed one-half of the average ebb-tidal excursion

- The 24-hour average full-power 2°C-above-ambient thermal barrier (measured during the critical periods) may not exceed 50% of the accessible cross-section of the receiving water body, both cross-sections taken in the same plane

- The 24-hour average area of the bottom touched by waters heated 2°C or more above ambient at full power (measured during the critical periods) may not exceed 5% of the bottom below the average ebb-tidal excursion.

C. USE OF BIOLOGICAL CRITERIA TO SUPPORT REQUESTS FOR ALTERNATE EFFLUENT LIMITATIONS

If any of the above mixing zone criteria are not satisfied, the owner/operator must request a variance (i.e., alternate effluent limitations) from them. Compliance with the biological criteria defined in Paragraphs G(1)(a) or G(1)(b) of COMAR 26.08.03.03 is the method required to demonstrate that existing operations protect balanced, indigenous populations to the required degree and support a variance request. Paragraph G(1)(a) requires a demonstration that the once-through cooling system has had no adverse impact on beneficial uses of the water body over at least a five-year period. Paragraph G(1)(b)(i-iv) requires a demonstration that plant operations has not resulted in:

- A significant increase in abundance or distribution of any species considered to be a nuisance species by MDE
- A significant change in biological productivity
- A significant elimination or impairment of economic and recreational resources
- A significant reduction on the successful completion of the life cycle of representative important species (RIS)

D. ASSESSMENT OF ENTRAINMENT IMPACTS ON SPAWNING AND NURSERY AREAS (GATE 2)

The second gate in Maryland thermal regulations [Paragraph C(2)(b)] requires a demonstration that the effects of cooling water entrainment does not adversely impact spawning and nursery areas of consequence for RIS (Fig. III-1.). In order to make this demonstration, an analysis must be conducted to determine which RIS use the Middle Branch as a spawning and nursery area. Then, the effects of facility operations on the early life stages of these RIS must be evaluated. Finally, the consequences of any plant effects to regional RIS populations must be determined. If spawning or nursery areas of RIS are adversely impacted (e.g., a significant reduction in the successful completion of the life cycle of an RIS), an evaluation must be conducted to identify the best available technology to mitigate impacts. The costs of installation and operations of any technologies identified may not be wholly disproportionate to the ecological benefits that result.

E. EVALUATION OF IMPINGEMENT IMPACTS (GATE 3)

The third gate in Maryland thermal regulations [Paragraphs C(2)(c) and F] requires that the magnitude of impingement and its monetary value be determined (Fig. III-1). The estimated monetary value of impingement is used to determine the extent (in dollars) to which utilities must reduce impingement losses by modifying intake structures or operating practices. The biological consequences of impingement must also be evaluated, including determination of the impact of impingement losses on spawning and nursery areas and on the successful completion of life cycles for RIS [Paragraphs C(2)(b) and G(1)(b)(iv)].

F. PROCESS FOR RENEWAL OF THERMAL DISCHARGE PERMITS

NPDES permits are reviewed and reissued approximately every five years or whenever operations of electric generating facilities are altered in a manner which substantially alters their environmental impacts. COMAR 26.08.03.03 does not specifically detail procedures that should be followed when permits are renewed. Available legal opinion, however, suggests the thermal variance granted as part of an NPDES permit expires with the permit (Appendix B).

Procedures that the U.S. Environmental Protection Agency recommend be followed when NPDES permits for thermal discharges are reissued are:

- The owner/operator should request that the variance be continued and provide a basis for requesting the continuance. The basis may be as simple as stating: (1) facility operating conditions and load factors are unchanged and are expected to remain so for term of the reissued permit; (2) no changes have occurred to facility discharges or other discharges near the facility which could affect the magnitude of impacts; and (3) there are no changes to the biotic community of the receiving water body which would impact the previous determination.

- If the appropriate permitting authority agrees with the basis, appropriate permit conditions should be developed. Otherwise, additional data should be requested. Requests for additional data must be made within 60 days of receipt of the application. Additional studies can be made a requirement of the new permit if they are needed to obtain the data required to help make a permit determination.

- A summary (fact sheet) of previous permitting decisions for the facility should be prepared. This summary should provide the rationale and justification for continuing the thermal variance. It should also clearly define the requirements of the new permit (e.g., alternate effluent limitations allowed). The summary should be made available to all interested parties during the process used to inform the public of the decision to continue the variance.

G. NEWLY PROPOSED THERMAL REGULATIONS

MDE is in the process of developing new thermal discharge regulations and recently published a draft of the proposed new regulations. Key differences between the current and proposed new thermal regulations that are relevant to the BRESCO permit renewal are:

- Mixing zone specification E(1)(a) in current regulations will be eliminated by the proposed new regulation.

- The proposed new regulation requires that requests for alternate effluent limitations must "show that the alternate effluent limitation desired by the discharger, considering the cumulative impact of its thermal discharge together with all other significant impacts on the species affected, including impingement and entrainment impacts, will assure protection and propagation of a balanced, indigenous community..." The proposed new regulations therefore require applicants to address the combined impacts of their intakes and discharges as well as the interactions of their intakes and discharges with the impacts associated with other facilities. The current regulations do not require applicants to assess cumulative impacts in their requests for alternate effluent limitations.

- The proposed new thermal regulations list 10 ecological factors, which must be addressed in variance applications to show that balanced indigenous communities are protected. These factors parallel the four effects listed in Paragraph G(1)(b)(i-iv) of the current thermal regulations. However, many of the potential effects that the proposed new regulations require to be specifically addressed are frequently not considered a part of the current permit evaluation procedures for thermal discharges (e.g., impacts on threatened or endangered species, blockage of migration routes, impacts on food web dynamics, cold shock impacts). Thus, if the proposed regulations are promulgated, considerable "new" data may be required as a part of future BRESCO applications for a thermal variance.

- The proposed new regulation requires the permittee to demonstrate whether entrainment losses "result in significant adverse environmental impact." Significant is defined as having an observed effect which is measurable beyond the mixing zone. The current regulations require determination of whether entrainment affects a spawning or nursery area of concern for RIS. Thus, empirical entrainment studies and nearfield/farfield entrainment sampling would be required as a part of any future BRESCO requests for a thermal variance if the proposed new regulations were promulgated.

IV. COMPLIANCE EVALUATION

Data available in existing reports (e.g., Ecological Analysts, Inc. 1983; EA Engineering, Science, and Technology, Inc. 1987; and Cadman 1987) were used to assess the degree to which the BRESCO facility complied with mixing zone specifications and biological criteria in COMAR 26.08.03.03. Results of this assessment are summarized in Table IV-1 and are discussed in the paragraphs that follow. This assessment is the basis that was used in Chapter V to develop conclusions about the consequences of observed impacts to receiving waters and can be used to formulate recommendations for conditions that should be included in the new NPDES permit for the BRESCO facility.

A. DETERMINATION OF COMPLIANCE WITH MIXING ZONE SPECIFICATIONS

The BRESCO facility probably complies with mixing zone specifications E(1)(c) and clearly fails mixing zone specification E(1)(a) of COMAR 26.08.03.03 (EA Engineering, Science, and Technology, Inc. 1987; Cadman 1987). The available hydrothermal data for the BRESCO facility (EA Engineering, Science, and Technology, Inc. 1987) are not adequate to determine if operations comply with mixing zone specifications E(1)(b) and E(1)(d) (Cadman 1987). The major deficiencies in the available data are:

- Procedures used to estimate ambient temperature were biased low
- Temperature was measured over too small an area around the discharge diffuser to estimate the percent bottom area touched by the 2°C above ambient isotherm and the maximum radial extent of the 2°C above ambient thermal plume
- Thermal plume studies were conducted on only one date and may not be representative of average or typical conditions.

Because of the deficiencies in the available hydrothermal data, alternate effluent limitations cannot be defined on a physical basis.

Table IV-1. Assessment of compliance of the BRESCO facility with evaluation criteria in COMAR 26.08.03.03

Evaluation Criteria	Decision Point for Compliance with Evaluation Criteria	RIS or Biota Used	Compliance Recommendation	Technical Basis for Compliance Recommendation	Consequences of Failure
1. Discharge flow may not exceed 20% of annual average net flow available for dilution	Plant discharge flow may not exceed 31 m^3/min	N/A	Fail	Thermal discharge (68 m^3/min) is ~ 200% average net flow (158 m^3/min) available for dilution	The BRESCO facility does not meet all thermal discharge specifications and must apply for alternate effluent limitations using procedures outlined in COMAR 26.08.03.03. If new thermal regulations are promulgated, this criterion would be eliminated.
2. Maximum radial dimension of 2°C isotherm may not exceed 1/2 of the average ebb tidal excursion	The maximum radial extent of the 2°C isotherm may not exceed ~ 95 m	N/A	Probable failure	Temperatures were not measured over large enough area around the discharge diffuser to determine the maximum radial extent of the 2°C above ambient thermal plume. Also, the ambient temperature used to calculate ΔTs was biased low.	If criterion 1 above is eliminated by the promulgation of new thermal regulations, compliance of the BRESCO facility with this criterion may become an important issue
3. Cross-section of 2°C isotherm may not exceed 50% of accessible cross-section of receiving water body	The 2°C isotherm cross-sectional area may not exceed ~ 830 m^2	N/A	Conditional pass	The 2°C above ambient thermal plume only affects a small portion of the available cross section of the Middle Branch	N/A
4. Bottom area touched by water heated 2°C or more above ambient may not exceed 5% of bottom area below the average ebb tidal excursion	Bottom area touched by water heated 2°C or more above ambient may not exceed 8,075 m^2	N/A	Probable failure	Temperatures were not measured over a large enough bottom area around the discharge diffuser to estimate the area of bottom touched by discharge waters heated 2°C or more above ambient. Also, the ambient temperature used to estimate ΔTs was biased low. Best available estimates of the area covered by the 2°C above ambient isotherm are from 7,849 m^2 to 17,649 m^2.	If criterion 1 above is eliminated by the promulgation of new thermal regulations, compliance of the BRESCO facility with this criterion may become an important issue.

Table IV-1. Continued

Evaluation Criteria	Decision Point for Compliance with Evaluation Criteria	RIS or Biota Used	Compliance Recommendation	Technical Basis for Compliance Recommendation	Consequences of Failure
5. No adverse impacts on spawning and nursery functions	Entrainment, impingement, or thermal discharge effects may not result in significant loss of spawning or nursery functions, including migration of adults or of young-of-the-year to spawning and nursery grounds	Spot Bay Anchovy Blue crab White perch	Pass	The BRESCO facility is sited in a relatively poor spawning and nursery habitat for RIS. However, improvements in environmental quality in the Harbor may lead to increased importance of RIS spawning and nursery functions in the vicinity of the BRESCO facility in the future.	N/A
6. No significant increase in the abundance of nuisance species	Plant-related impacts may not result in increases in the distribution or abundance of nuisance organisms	Blue-green algae; fish parasites; Zooplankton parasites	Probable pass	Any enhancement of nuisance species would be localized due to small size and relatively low absolute temperatures of the thermal plume	N/A
7. No significant change in biological productivity	Plant-related impacts may not result in changes in biological, especially primary productivity that subsequently affect higher trophic levels	Phytoplankton RIS fish	Probable pass	Any change in primary or secondary productivity or fish growth/condition would be localized due to small size and low absolute temperature of the thermal plume	N/A
8. No significant elimination of impairment of economic or recreational resources	Plant-related impacts may not result in significant declines in commercial or recreational fishing or in boating, swimming, or other recreational uses of the water body	Blue crab White perch Spot Eels	Pass	Plant impact on recreationally important fish and crabs is expected to be low due to small size and low absolute temperature of the thermal plume. Nuisance algal blooms that might interfere with boating activity are expected to be improbable. Impingement of recreationally or commercially important fish or crabs is small and does not impact an important spawning or nursery area.	N/A
9. No significant reduction in successful completion of life cycle of RIS	Plant-related impacts on spawning or nursery activities of RIS may not result in appreciable long-term declines in population abundance	Spot Bay anchovy Blue crab *Macoma balthica* White perch	Probable pass	Abundance of *Macoma balthica*, spot, anchovy, and blue crab are low in Middle Branch relative to the outer Harbor and the upper Chesapeake Bay. White perch occurs (and possibly spawns) in the Middle Branch, but its abundance is extremely low.	N/A

B. DETERMINATION OF COMPLIANCE WITH BIOLOGICAL CRITERIA IN PARAGRAPH G(1)(b)

Because the BRESCO facilty failed to comply with all mixing zone specifications in COMAR 26.08.03.03, existing operations must be shown to assure the protection and propagation of balanced indigenous populations using biological criteria in Paragraphs G(1)(a) or G(1)(b) before a thermal variance can be approved or renewed. The biological data required to evaluate compliance of the BRESCO facility with Paragraph G(1)(a) do not exist. Therefore, the criteria in Paragraph G(1)(b) were used to make the necessary compliance determination. Our compliance determination is summarized in Table IV-1 and is discussed below.

The BRESCO thermal plume is small and localized and absolute plume temperatures only occasionally exceed levels that are likely to cause direct mortality or biological stress (35°C). As a result, no increases in the abundance or distribution of nuisance species (e.g., plant-related increases in frequency of blue-green algal blooms; plant-related increases in the distribution, abundance, or frequency of occurrence of fish or zooplankton parasites or disease) are anticipated (Ecological Analysts, Inc. 1983). The small and localized nature of the BRESCO thermal plume also suggests that adverse plant effects on biological productivity, including growth or condition of indigenous biota, and the successful completion of the life cycle of RIS are likely to be small and limited to the immediate discharge region.

Fish movement in the vicinity of the BRESCO facility is mainly limited to onshore-offshore movement associated with seasonal changes in temperature (O'Dell et al. 1975; Wiley 1975). Gwynns Falls is not currently a spawning habitat for anadromous or semi-anadromous species, and no major fish migratory routes occur in the vicinity of the BRESCO intakes or discharges (O'Dell et al. 1975). Even if the Middle Branch was an important migratory route for fish spawning absolute plume temperatures and plume size of the BRESCO facility would not likely have adverse effects. Absolute plume temperatures are also not likely to attract significant numbers of fish in winter and cause cold shock mortalities during facilty shutdowns. No fish kills (summer or winter) have been reported to be associated with the BRESCO operations.

Commercial fishing does not occur in the Middle Branch, and recreational fishing in the vicinity of BRESCO is mainly limited to that which occurs along shorelines and from bulkheads (N. Carter, personal communication). No shellfish grounds or extensive wetlands or beds of submerged aquatic vegetation have been reported in the area. Shoreline beaches are not suitable for swimming, and the poor visual quality and shoaling characteristic of the area make it undesirable for recreational boating. The salinity of the water in the Middle Branch is too high to be used as a drinking water source. No rare or endangered species have been reported from the area, and available habitat characteristics indicate none are likely to exist in the immediate vicinity of the BRESCO site. There are no safety or health restrictions on water use in the vicinity of the BRESCO facility.

C. ENTRAINMENT IMPACTS ON SPAWNING AND NURSERY AREAS

No empirical data exists with which to estimate entrainment rates or address possible entrainment impacts on spawning and nursery areas of RIS which may occur in the vicinity of the BRESCO facility. However, in the initial BRESCO NPDES permit application, the life history characteristics of RIS that were abundant in the Middle Branch were described and historical distribution data were used to demonstrate that the region was a low quality spawning and nursery habitat compared to less polluted regions of Baltimore Harbor or the Upper Bay (Ecological Analysts, Inc. 1983). Based on this information, MDE and PPER concluded that the potential for entrainment impacts on RIS was low. Although there is no specific evidence to suggest that these conditions have changed and that this conclusion should be modified, some recent data suggest pollutant loadings to the Baltimore Harbor have declined markedly and that the biota of the region are responding favorably. For example:

- Abundances of some pollution sensitive benthic taxa have increased eight-fold since the early 1970s (Holland et al. 1988).

- The number of blue crabs impinged at BRESCO was much higher than anticipated based on historical impingement data for adjacent Baltimore Harbor power plants (EA Engineering, Science, and Technology, Inc. 1987).

- Brown trout and other pollution-sensitive species were present in impingement samples from the BRESCO facility and appear to be more abundant in the Middle Branch than when the facility was first constructed (EA Engineering, Science, and Technology, Inc. 1987).

- The abundance and diversity of finfish in the Middle Branch are much greater now than they were in the 1970s (Wiley 1975; Kazyak et al. 1988).

Thus, although the Middle Branch is currently not an important spawning and nursery area for RIS, spawning and nursery activities are expected to become more important in this region in the future.

D. EVALUATION OF IMPINGEMENT LOSSES

Twenty species of finfish and two invertebrates were collected during the 1985-1986 impingement studies at BRESCO (EA Engineering, Science, and Technology, Inc. 1987). Blue crab, Atlantic menhaden, grass shrimp, mummichog, and Atlantic silverside composed 95 percent of the total annual catch. Impingement rates were highest in spring and summer. Total estimated impingement for the year was 80,178 finfish and invertebrates with a COMAR value of $14,702 (EA Engineering, Scicnce, and Technology, Inc. 1987). Blue crabs and Atlantic menhaden accounted for 97.4 percent of this total value. The above COMAR valuation assumed 100 percent mortality for all species. When a more realistic mortality rate (~ 12%) was used for blue crabs, the COMAR dollar value of impingement losses was estimated to be $2,746 (Cadman 1987).

V. SUMMARY AND CONCLUSIONS

Thermal discharges for the BRESCO facility are relatively small and localized. They are not likely to block fish migration routes or adversely affect spawning and nursery activities. In addition, absolute plume temperatures are not of a magnitude likely to cause adverse biological impacts (e.g., mortalities, reduced growth). The thermal plume fails to comply with all thermal mixing zone specifications in current Maryland thermal regulations [(i.e., it fails specification E(1)(a)]. Deficiencies in the available hydrothermal data prevent a determination from being made as to whether the facility complies with remaining mixing zone specifications.

MDE is presently in the process of promulgating new thermal regulations, if the proposed new regulations are promulgated, mixing zone specification E(1)(a) will be eliminated. If this were to occur, compliance of the BRESCO facility with the remaining mixing zone specifications is likely to become an issue. Additional hydrothermal measurements would be required to determine whether or not the BRESCO facility complies with the remaining mixing zone criteria.

No detailed biological studies were conducted to assess discharge and entrainment impacts for the BRESCO facility. Rather, historical literature data were used to determine that:

- Discharge impacts on the abundance, distribution, productivity, and life cycle of RIS and potential nuisance species were likely to be small
- Operation of the BRESCO facility is unlikely to impair or eliminate economic or recreational resources or adversely impact other beneficial uses of the Middle Branch
- Entrainment losses to RIS do not presently impact a spawning and nursery area of consequence, and the costs of alternative intake technologies to reduce entrainment impacts would be large relative to the negligible biological gains that would result

The existing BRESCO intake structures are the best available technology for mitigating entrainment losses. However, if the environmental quality of Baltimore Harbor continues to improve the significance of the Harbor as a spawning and nursery area will likely increase and the biological gains associated with a reduction of entrainment losses may be sufficient to justify the cost of retrofitting alternative intake technologies.

Impingement losses were extremely low relative to other electric-generating facilities in Maryland. The five-year COMAR dollar value of impingment losses is about $15,000. This value is not sufficient to justify modifications to plant operation or intake structures to mitigate impingement losses. Therefore, the existing intake structure represent best available technology for mitigating impingement loss.

VI. RECOMMENDATIONS

When the BRESCO NPDES Permit is renewed in 1989, it should contain provisions that require biological studies to:

- Identify the resources at risk to entrainment and provide a basis for estimating the approximate magnitude of entrainment losses
- Characterize the status and trends of RIS fish resources that use the BRESCO region of the Middle Branch as a nursery area.

A two-year (1989-1991) macroplankton survey is recommended to identify the organisms at risk to entrainment, and a long-term (1989-1994) beach seine monitoring program is recommended to characterize the status and trends in nearshore fish resources that use the Middle branch as a nursery habitat. Study plans for these studies should be reviewed by MDE and MDNR/PPER before sampling is initiated. Data collected by these studies should be provided to MDE and MDNR/PPER annually. In addition, an interpretative report that assesses the relative importance of the Middle Branch as a spawning and nursery habitat should be prepared in 1991, and in 1994, a report summarizing the findings of the beach seining monitoring program should be prepared. Both of these reports should include comparisons of the collected data to that reported for similar habitats in other regions of the Chesapeake Bay as well as to that historically reported for Baltimore Harbor. Recommended study methods for the macroplankton survey and the beach seine monitoring program are provided in Appendix C.

The information resulting from the macroplankton surveys will be analyzed by MDNR/PPER in early 1991 using the Spawning and Nursery Area of Consequence (SNAC) model to determine if additional entrainment sampling, including more RIS population studies, in-plant entrainment sampling, and/or detailed modeling to assess the consequences of entrainment losses to regional RIS populations (e.g., the Empirical Entrainment Model) should be required. In the unlikely event additional entrainment studies are required, they should be conducted in the 1992-1993 time frame. The results of any additional entrainment studies required should be presented in an interpretative report that provides the basis for BRESCO's 1994 NPDES permit renewal.

Additional impingement sampling need not be required by the 1989 BRESCO NPDES perimt. This is because:

- Impingement losses at BRESCO are extremely small (80,178 fish and crabs with a COMAR annual dollar value of < $3,000)

- Impingement losses of this magnitude do not threaten balanced indigenous populations in receiving waters

- The costs of modifying intake structures or their operations would be disproportionate to any ecological benefits that would result.

As previously discussed, the existing intake structures at BRESCO should be viewed as the best available technology for reducing impingement impacts. Additional impingement data are not likely to change this conclusion over duration of the 1989 BRESCO NPDES permit (i.e., the next five years).

Even though the existing hydrothermal data are not adequate for determining compliance with the mixing zone specifications in Maryland thermal regulations, we do not recommend the 1989 BRESCO NPDES permit require additional hydrothermal studies. The reasons for this recommendation are:

- Available hydrothermal data indicate the thermal plume is small and localized

- Absolute plume temperatures are not of a magnitude likely to cause adverse harm in receiving waters

- No adverse impacts have been associated with the BRESCO discharge plume (e.g., fish kills, algae blooms)

- The existing diffuser system rapidly disperses waste heat

- Alternative technologies for reducing thermal loadings (e.g., a closed-cycle cooling system, an auxiliary tempering water system) are expensive to retrofit and are not likely to result in substantial ecological benefits. In addition, these technologies may cause additional environmental harm or raise new issues. For example, an auxiliary tempering water system would increase entrainment losses, and a closed-cycle cooling system would result in considerable traffic safety concerns related to fogging and icing of the adjacent interstate highway system.

BRESCO should probably conduct additional hydrothermal studies that accurately characterize thermal plume dimensions for a range of tidal stages and heights without being required to do so as part of a NPDES permit requirement. This is because if BRESCO thermal discharges can be shown to comply with mixing zone specifications, future permit renewals and requests for permit modification (e.g., increases in generation capacity) would be facilitated. We recommend that plans for any future hydrothermal studies be reviewed by MDE and MDNR/PPER prior to initation of field collections

VII. REFERENCES

American Society of Civil Engineers (ASCE). 1982. Design of Water Intake Structures for Fish Protection. Prepared by ASCE, New York, NY.

Barnett, P.R.O., and B.L.S. Hardy. 1984. Thermal deformations. pp. 1769-1914. In: O. Kinne (ed), Pollution and Protection of the Seas: Pesticides, Domestic Wastes, and Thermal Deformations, Vol. V, Part 4 of Marine Ecology, A Comprehensive, Integrated Treatise on Life in Oceans and Coastal Waters, John Wiley & Sons, New York, NY.

Barnthouse, L.W., D.L. DeAngelis and S.W. Christensen. 1979. An Empirical Model of Impingement Impact. Prepared by Oak Ridge National Laboratory, Oak Ridge, TN. Ref. Nos. ORNL/NUREG/TM-290 and NUREG/CR-0639.

Barnthouse, L.S., and W. Van Winkle. 1981. The impact of impingement on the Hudson River white perch population. pp. 199-205. In: L.D. Jensen (ed), Issues Associated with Impact Assessment, Proceedings of the Fifth National Workshop on Entrainment and Impingement, Ecological Analysts, Inc., Sparks, MD.

Boreman, J., C.P. Goodyear, and S.W. Christensen. 1978. An Empirical Transport Model for Evaluating Entrainment of Aquatic Organisms by Power Plants. Prepared by the U.S. Fish and Wild. Serv., Biol. Serv. Prog., National Power Plant Team. Ref. No. FWS/OBS-78/90.

Cadman, L. 1987. Review of BRESCO's final report on impingement and hydrothermal studies. Prepared by Versar, Inc., ESM Operations, Columbia, MD, for the Power Plant Research Program, Maryland Department of Natural Resources, Annapolis, MD.

Capuzzo, J.M. 1979. The effect of temperature on the toxicity of chlorinated cooling water to marine animals -- a preliminary review. Mar. Poll. Bull. 10:45-47.

Carter, N. 1988. Personal Communication. Maryland Department of Natural Resources, Power Plant and Environmental Review, Annapolis, MD.

Clark, J.D., and W. Brownwell. 1973. Electric Power Plants in the Coastal Zone, Environmental Issues. American Littoral Society, Highland, NJ. Special Publ. No. 7.

Coutant, C.C. 1977. Compilation of temperature preference data. J. Fish. Res. Bd. Canada. 34:739-745.

Coutant, C.C., and S.S. Talmadge. 1977. Thermal effects. J. Water Poll. Control Fed. 49:1369-1425.

EA Engineering, Science, and Technology, Inc. 1987. Baltimore RESCO facility impingement and hydrothermal studies. Final Report July 1985-June 1986. Prepared by EA Engineering, Science, and Technology, Inc., Sparks, MD for the Baltimore Refuse Energy Systems Company, Baltimore, MD. EA Report RSC51E.

Ecological Analysts, Inc. 1983. A .13 Demonstration in support of the application for alternate effluent limitations. Prepared by Ecological Analysts, Inc., Sparks, MD for the Rust International Corporation, Birmingham, AL. EA Report RU531K.

Hanson, C.H., J.R. White, and H.W. Li. 1977. Entrainment and impingement of fishes in power plant cooling water intakes: an overview. Marine Fisheries Review 39:7-17.

Holland, A.F., and M.H. Hiegel. 1981. Results of benthic studies at Chalk Point. Prepared by Martin Marietta Environmental Center, Baltimore, MD for Maryland Department of Natural Resources, Power Plant Siting Program, Annapolis, MD. Ref. No. PPSP-CP-81-1.

Holland, A.F., A.T. Shaughnessy, L.C. Scott, V.A. Dickens, J. Gerritsen, J.A. Ranasinghe. 1988. Long-term benthic monitoring and assessment report for the Maryland portion of the Chesapeake Bay: Interpretative Report. Prepared by Versar, Inc., ESM Operations, Columbia, MD for the Power Plant Research Program, Maryland Department of Natural Resources, Annapolis, MD.

Kazyak, P.F., R.L. Dwyer, and S.B. Weisberg. 1988. Baseline characterization of the Gwynns Falls watershed prior to non-point sources remediation. Prepared by Versar, Inc., ESM Operations, Columbia, MD for the Tidewater Administration, Maryland Department of Natural Resources, Annapolis, MD.

Maryland Department of Natural Resources. 1984. Power Plant Cumulative Environmental Impact Report. Prepared for the Maryland Department of Natural Resources by the Power Plant Siting Program. Annapolis, MD. Ref. No. PPSP-CEIR-4.

O'Dell, J., J. Gabor, and R. Dintman. 1975. Survey of anadromous fish spawning areas: Completion Report. Project AFC-8, July 1970-January 1975. Maryland Department of Natural Resource, Fisheries Administration, Annapolis, MD.

Polgar, T.T., J.K. Summers, and M.S. Haire. 1981. Assessment of potential power plant entrainment impact at Morgantown Steam Electric Station. pp. 207-223. In: L.D. Jensen (ed.), Issues Associated with Impact Assessment, Proceedings of the Fifth National Workshop on Entrainment and Impingement, Ecological Analysts, Inc., Sparks, MD.

RUST Internation Corporation (RIC). 1983. NPDES permit application and supporting documentation for Baltimore RESCO. Prepared by RUST International Corporation, Birmingham, AL for the Maryland Department of Health and Mental Hygiene, Baltimore, MD.

U.S. Environmental Protection Agency (U.S. EPA). 1977(a). Interagency 316(a) Technical Guidance Manual and Guide for Thermal Effects Sections of Nuclear Facilities Environmental Impact Statements. U.S. EPA, Washington, DC.

U.S. Environmental Protection Agency (U.S. EPA). 1977(b). Guidance for Evaluating the Adverse Impact of Cooling Water Intake Structures on the Aquatic Environment. Section 316(b) P.L. 92-9500. U.S. EPA, Washington, DC.

University of Maryland. 1975. A Biological Study of Baltimore Harbor. Prepared by the University of Maryland, Center for Environmental and Estuarine Studies, Solomons, MD. CEES Special Report No. 6.

Veil, J. 1988. Personal communication. Maryland Department of the Environment, Baltimore, MD.

Wiley, M.L. 1975. Fish, pp. 70-100. In: T.S.Y. Koo (ed.). A Biological Study of Baltimore Harbor. University of Maryland, Center for Environmental and Estuarine Studies. Special Report No. 6.